

ERGONOMICS AND HEALTH CARE

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94-30401

This article provides a brief history of the field of ergonomics and explores the interrelationship between health care and ergonomic professions. Health care practitioners contribute a unique perspective to an ergonomic research and intervention team. This singular perspective is based on knowledge of health issues, disease and injury etiology and prognosis, and the psychosocial impact of illness. Topics for collaboration between health care practitioners and ergonomists are identified.

Keywords: Ergonomics; Human factors; Work; Rehabilitation

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DEVELOPMENT OF A PROFESSION

Ergonomics (*ergo* means work, *nomics* means the study of) has gained notoriety in recent years as a professional field and as a body of knowledge

used for specific applications. Recognition of the term by the general public attests to the increase in its popularity. The term has been used outside the scientific community in advertising as a marketing device and in nontechnical magazines, such as *Better Homes and Gardens* (Roffmann, 1993). The prominence of ergonomics is also evident in the health care arena, as ergonomic principles are used to design environments that ensure safety and ease of use for all populations. Although *human factors* has been the more prevalent term in the United States and *ergonomics* has been the more prevalent term in Europe (Gay, 1986; Meister, 1986; Fraser, 1989; Wilson and Corlett, 1990), the terms *human factors* and *ergonomics* are considered synonymous (Chapanis, 1991; Sanders and McCormick, 1987). It is acknowledged, however, that many individuals use these terms to pertain to more physically oriented interventions.

The underlying concepts of human factors/ergonomics have existed since the Stone Age, when humans constructed hunting and gathering tools to fit their anthropometric dimensions; however, the profession itself has developed fairly recently. The early proponents of human factors/ergonomics in the United States were time and motion experts (Taylor, 1911; Gilbreth, 1911).

Portions of this article are taken from Rice (in press)

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WORK 1994; 4(3):156-161

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According to Osborne (1982, p. 3), the members of the Health of Munitions Workers' Committee and later the Industrial Health Research Board (1929) were some of the early predecessors of the field in England. The Industrial Health Research Board was designed to investigate the conditions of industrial employment "particularly with regard to the preservation of health among the workers and industrial efficiency" and consisted of psychologists, physiologists, physicians, and engineers. They investigated postures, carrying loads, the physique of men and women, rest pauses, inspection, lighting, heating, ventilation, selection, training, and the use of music during work.

The wartime effort during World War II hastened development of the field of ergonomics. At that time, the complexity of military equipment surpassed the abilities of the human operators (Chapanis, Garner, and Morgan, 1949; Meister, 1986; Smith, 1987) and "man had become the weak link" (Damon, Stoudt, and McFarland, 1966). As during World War I, the primary focus of human factors/ergonomics was personnel selection and training, that is, "fitting the human to the task." However, even with extensive training, humans could not always be brought up to par (Sanders and McCormick, 1987). Realizing that humans could not redesign themselves and that selection and training were not providing an acceptable solution, the focus of ergonomics changed to "fitting the task to the human." This change encouraged the use of human dimensions, capabilities, and limitations in the design process.

The practice of ergonomics during World War II was accomplished by interdisciplinary teams of government researchers dedicated to improving human performance in the military work arena. Military work demands posed questions about human performance at excessive speeds and altitudes, in extreme environmental conditions, and in new situations such as human/machine handling of radar, ships, and tanks. No single traditional field (psychology, medicine, anatomy, engineering) appeared to be able to answer all of the questions raised. Therefore ad hoc interdisciplinary teams were developed (Shephard, 1974).

The successful problem-solving skills of these teams of researchers were refocused on nonmili-

tary environments following World War II. Developed from the common interests of a number of professions, particularly engineering, psychology, and medicine, ergonomics has since remained a multidisciplinary field of study. Present-day ergonomists include professionals with degrees in psychology, engineering, human factors/ergonomics, industrial design, education, physiology, medicine and allied health, business administration, computer science, and industrial hygiene.

After the second world war, the Ergonomics Research Society (currently the Ergonomics Society) was founded in England, and the first ergonomics text, *Applied Experimental Psychology: Human Factors in Engineering Design* was published (Chapanis, Garner, and Morgan, 1949). In 1957 the Human Factors Society was formed in the United States, and the journal *Ergonomics* was published by the Ergonomics Research Society. The International Ergonomics Association was formed in 1959 to join ergonomics and human factors societies from several countries.

Even as the field of ergonomics flourished, growth pains began. Professional academic programs were established, but no guidelines existed to monitor either the programs or their graduates. The number of persons claiming the title of professional ergonomist grew, and concern developed regarding their professional skills. One of the goals of ergonomic consultation and intervention is to ensure safety in the workplace. An individual who identifies him or herself as an "ergonomist," but does not have sufficient training in the profession, may make errors of commission (unsafe design) or omission (lack of sufficient knowledge and consequent incomplete application of principles) during ergonomic consultation. Instead of ensuring safety, their consultation and ergonomic design suggestions could actually result in harm. The Human Factors and Ergonomics Society sought to address problems in academic and professional competency.

Seventy-one professional programs now exist at sixty different colleges and universities in the United States (Human Factors and Ergonomics Society, 1991). Nine university programs have passed an accreditation process, initiated in 1989 and sponsored by the Human Factors and Ergo-

nomics Society. Professional certification is being addressed through the Board of Certification for Professional Ergonomists (Board of Certification in Professional Ergonomics, 1993) and has been discussed by health care professionals (Hart, Isærn-hagen, and Matheson, 1993; Rice and Jacobs, 1993).

The number of publications and journals dedicated to ergonomics have grown. (Some examples include *Ergonomics*, *Applied Ergonomics*, *Human Factors*, *Human Factors in Design*, *Work and Stress*, and *International Journal of Industrial Ergonomics*.) The number of articles on ergonomic topics have proliferated in related literature. The Occupational Safety and Health Administration (OSHA) has published a draft entitled "Ergonomics Program Management Recommendations for General Industry." The process for converting the draft into guidelines similar to the *Ergonomics Program Management Guidelines for Meatpacking Plants* is in the rule-making stage (U.S. Department of Labor, 1991; Occupational Safety and Health Administration, 1992). This means that written comments have been accepted and a new draft will be published. Public hearings will be held to gather information and opinions from interested constituents, prior to developing an OSHA guideline. The American National Standards Institute (ANSI) has also published a thorough draft entitled "Control of Cumulative Trauma Disorders" (American National Standards Institute, 1993).

Finally, to the joy of the ergonomics professional, the field is gaining the recognition it deserves. But the growing pains have become significantly more acute with rapid growth and notoriety. The primary concerns for public welfare and competence of ergonomic professionals occasionally waiver and dissipate into unattractive, nonproductive professional turf wars.

DEVELOPMENT OF A CONCEPT

The term *ergonomics* was first coined by K. F. H. Murrell, a British ergonomist. According to Osborne (1982), the term was adopted on February 16, 1950, at a meeting for persons interested in human work problems. After the focus of ergo-

nomics transferred from the military work environment to the industrial work environment, the concept continued to develop, as depicted in the broadening of definitions used to explain human factors/ergonomics. According to Sanders and McCormick (1987), "Human Factors/Ergonomics focuses on humans and their interaction with products, equipment, facilities, procedures, and environments used in work and everyday life." In an effort to improve work and living conditions, scientific investigations are conducted on human limitations, capabilities, preferences, and responses. Researchers also conduct investigations to evaluate objects, tools, machines, equipment, tasks, jobs, and environments to ensure they meet their intended objectives; thus ergonomists seek to optimize work and living conditions.

In order to optimize the relationship between the environment and the human, ergonomists must use factors about people, that is, human characteristics. These characteristics include anthropometry, audition, vision, strength, cognition, and information processing, to name a few. Thus, ergonomists make the world user-friendly for people by designing specifically for humans. The consequence of human-centered design is that environments, systems, equipment, and so forth become easier (more intuitive) to use. Less pre-use training is required and more efficient, effective, and safe use results. The final outcome is improved quality of life. Designing to prevent human error and promote safety is important, because "no amount of training will overcome the tendency of an operator to 'do what comes naturally' when placed under stress" (Osborne, 1982, p. 3).

There are three important points to consider when discussing the field of ergonomics:

1. The core of ergonomics is design, based on research results.
2. Ergonomics should be viewed from a systems-level perspective (macroergonomics) as well as from the traditional tool and work space perspective (microergonomics).
3. The concepts of work-related ergonomics apply equally to nonwork environments.

Our homes, playgrounds, utensils for activities of daily living, recreation equipment and facilities, and transportation systems should all be designed based on human dimensions and capabilities. While the primary emphasis remains on the work environment, the field of ergonomics is moving to encompass other environments and applications. Macroergonomics provides guidance for organizations using a systems approach (Hendrick, 1992). Ergonomic principles can be applied in nonwork environments when using consumer products; participating in activities of daily living (Czaja and Nair, 1992); driving an automobile (Kline and Fuchs, 1993); finding one's way through a complex building (Butler, Acquino, Hissong, et al., 1993); and recreating (Ryschon and Stray-Gunerson, 1993).

A SPECIFIC APPLICATION: HEALTH CARE

Three primary applications of ergonomics in health care are 1) work-site analysis to prevent cumulative trauma injury, 2) ergonomic design for individuals with disabilities, and 3) medical equipment design. Both ergonomists and health care practitioners have provided consultation in each of these areas.

According to a review in 1989, the previous 20 years of issues of the journal *Human Factors* contained only 52 articles that directly applied to rehabilitation issues (V. J. Rice and P. M. Sind, unpublished observation, 1989). Although rehabilitation issues are not considered mainstream ergonomics, human-factors professionals/ergonomists are well aware of the need for implementation of ergonomic principles during rehabilitation and when returning the injured worker to work (Shephard, 1974; Rice and Sind, 1991; Alexander, 1986; Moore and Garg, 1992). The interest of professional ergonomists is evident in the Human Factors and Ergonomics Society technical group, *Medical Systems and the Functionally Impaired*. The following ergonomic rehabilitation issues have been identified as needing further research:

- Usability testing of medical and rehabilitation equipment (Rice, 1992).
- Work-space and equipment design for individuals with functional limitations (Alexander, 1986; McQuistion, 1993).
- Training.
- Collection and synthesis of anthropometric data (Rice and Sind, 1991).

For years, health care professionals have used ergonomic principles in individual patient treatment and education, but they have not used the term *ergonomics*. With increased emphasis on injury prevention, some health care professionals are focusing their practices on a combination of patient treatment (work hardening) and ergonomic intervention. For example, ergonomics and occupational therapy are closely related. Ergonomics professionals study the interaction between the human and his or her environment. Their primary focus is research, analysis, and design. Occupational therapists focus on the activities (occupations) that comprise one's life. Their primary concern is patient care. Both fields claim expertise in human performance. Ergonomics evaluates human performance in relation to human/environment interaction, while occupational therapy examines human performance in relation to activity.

Few health care professionals seek to abandon health care to become ergonomists, rather they endeavor to apply ergonomic principles in rehabilitation and work-site injury prevention. Health care professionals have knowledge and skills to offer that differ from those offered by ergonomists. Their distinctive knowledge includes health issues, disease and injury etiology and prognosis, and the psychosocial impacts of illness. Although the focus of health care professionals is on patient treatment and illness/injury prevention, they have made some unique contributions to the field of ergonomics, including the following:

1. Knowledge of disease, injury, and congenital conditions—etiology, prognosis, treatment, and psychosocial impact.
2. Initial identification of injury/illness trends (based on patient data).

3. Functional evaluation of individuals.
4. Occupational evaluation of an individual (potential to resume occupational roles at work, at home, and during leisure activities).
5. Vocational training.
6. Work hardening and job simulation.
7. Transitional (light-duty) evaluation and assignment.
8. Educational programs on health issues in the workplace (etiology and prognosis of cumulative trauma injuries and other conditions, body mechanics, back schools, physical fitness, stress management, wellness, behavioral management of weight control, communication skills, and so on).

Ergonomists do not wish to become health care practitioners, rather they seek to use their proficiencies to better assist a specific population. Certainly, ergonomists have valuable knowledge and skills that differ from those offered by health care professionals. For example, ergonomists may have greater understanding of the contrast, spacial, and temporal resolution of video-display terminals (important for some job analysis or work-site evaluations).

Although some believe that battle lines have

been drawn between ergonomists and health care professionals, the field of ergonomics is replete with opportunities. The goals of the two professions are similar (expressed as goals for the individual and goals for the general work force): to prevent injury and promote safety, to establish independence and boost efficiency, and to foster competence and improve effectiveness. Essentially, the true goal of ergonomics professionals is to "put themselves out of work" by creating a world that is user-friendly, utilizes (enhances) human abilities while recognizing limitations, guarantees a safe environment, and promotes effectiveness and efficiency. A blending of professional interests in a team approach may re-create the atmosphere of the ad hoc groups from whence the ergonomics profession began. This blending may also create well-rounded interventions that benefit both the user groups (general public and individuals with disabilities) and the team members themselves.

The University of Miami Comprehensive Pain and Rehabilitation Center uses such a team approach and reports positive results (Khalil, Abdel-Moty, Asfour, et al. 1991). Their patients, the public, and even the professionals involved deserve the benefits of cooperation. It is time for this approach to be the rule rather than the exception.

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